Space Weather Technical Forecast

Issued on Tuesday, 07 December 2021 at 12:48 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor Storms on the 9th and 10th.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Very Low over the past 24 hours, with only a minor B-class flare. There is currently only one sunspot region on the visible disc, AR2904, which is a small, simple and stable Beta/Bxo, situated in the southeast quadrant. No Earth-directed CMEs (coronal mass ejections) have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, varied between slightly elevated to elevated, between 460km/s and 520km/s, due to an ongoing connection to a fast solar wind of CH27/28 (no longer visible on the disc). Density has been around average to slightly above, between 6-17ppcc during the period. The total interplanetary magnetic field strength (IMF) Bt, was weak, generally between 3 and 7nT, with the all important north-south (Bz) component also weakly positive (northward) and negative (southward), with a range of +5/-5nT. The phi angle was predominately positive (away from the Sun). The resultant geomagnetic activity was generally Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels. The high energy electron flux (greater than 2 MeV) was at Moderate to High levels, with a peak through the diurnal cycle of 2150pfu at 06/1705UTC. The associated 24-hour integrated fluence was below the Active threshold (1e8 integrated pfu), with 5e7 integrated pfu observed at 07/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low or Very Low, with the chance of further notable flares from around the limb now significantly decreased, leaving one current front-sided sunspot.

Solar Wind / Geomagnetic Activity: There are three potentially Earth-directed CMEs in the forecast.

The first CME in the forecast is from a filament eruption on Friday 03 December, scheduled to pass 1AU as a near-miss of Earth on day 1 (Tuesday 07 December). A placeholder 5% risk of G1 is included as a result.

The second CME is a faint emission from a filament eruption on Sunday 05 December, and is expected to arrive on Thursday 09 December 1800UTC +/-9 hours, but again confidence is low due to limited imagery for analysis.

The third CME which left the Sun as a filament lift-off late on 05 December will likely arrive at Earth as a weak feature on Friday 10th December around 0900 UTC +/-12hrs.

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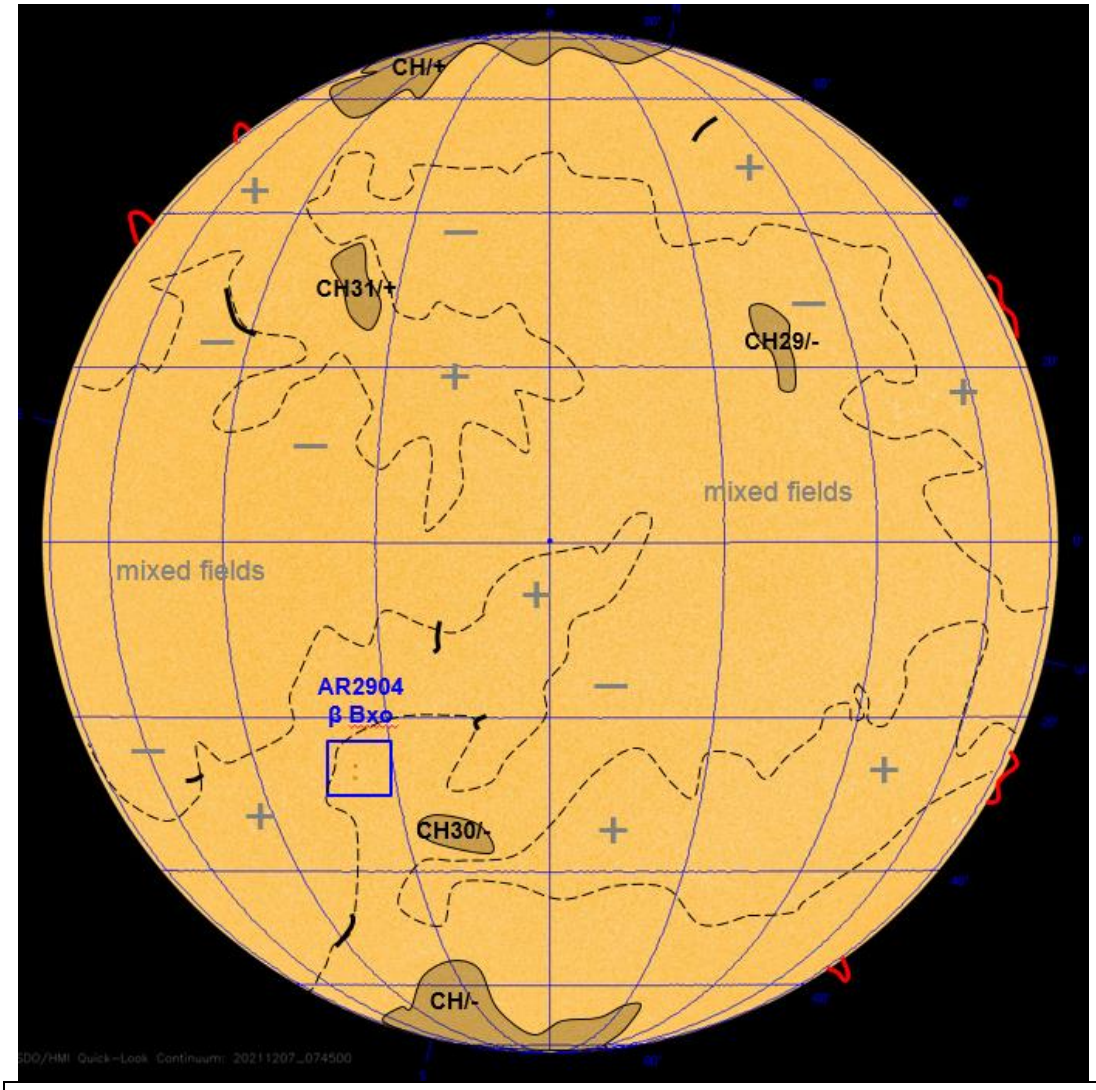
The current fast wind from CH27/28 is expected to ease during day 1 (Tuesday 07 December), before a further fast wind enhancement is possible towards the end of day 3 (Thursday 09 December) from CH29. All considered, geomagnetic activity is expected to be Quiet to Unsettled, with Active intervals during the period, with a Very Slight Chance of G1 on day 1 from the probable near miss from the 03 December CME, with a 20% Chance of G1/Minor Storms on Thursday 09 and Friday 10 December should the CMEs arrive, perhaps coinciding with the arrival of CH29 fast solar wind.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels.
The high energy electron flux (greater than 2 MeV) is likely to be at Moderate to High levels. The associated 24-hour integrated fluence is expected to persist below the Active threshold, but with a rising trend, giving a Chance of rising above, mainly on days 1 and 2 (Tuesday 07 December or Wednesday 08 December). Confidence is low beyond the immediate term owing to the number of (potential) transients in the forecast.

Figure 1. Solar Analysis Valid 07/0745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are three potentially Earth-directed CMEs in the forecast.

The first CME in the forecast is from a filament eruption on Friday 03 December, scheduled to pass 1AU as a near-miss of Earth on day 1 (Tuesday 07 December). A placeholder 5% risk of G1 is included as a result.

The second CME is a faint emission from a filament eruption on Sunday 05 December, and is expected to arrive Thursday 09 December 1800UTC +/-9 hours, but again confidence is low due to limited imagery for analysis.

The third CME which left the Sun as a filament lift-off late on 05 December will likely arrive at Earth as a weak feature on Friday 10th December around 0900 UTC +/-12hrs.

The current fast wind from CH27/28 is expected to ease during day 1 (Tuesday 07 December), before a further fast wind enhancement is possible towards the end of day 3 (Thursday 09 December) from CH29. All considered, there is a Very Slight Chance of G1 on day 1 from the probable near miss from the 03 December CME, with 20% Chance of G1/Minor Storms on Thursday 09 and Friday 10 December should the CMEs arrive, perhaps coinciding with the arrival of CH29's fast wind.

Coronal holes of either polarity are near their semi-annual minimum potency at the minute, with Earth crossing the solar equatorial plane northwards on day 2, Wednesday 08 December, minus any transient activity (confirmed or otherwise), the unperturbed wind and its effects ought to be unremarkable in the four-day period, as on previous rotations.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
05/2200	Partial	Filament eruption	SE quadrant	310km/s	10/0900UTC	Limited shock expected
05/1300	Partial	Filament eruption	South Centre disc	325km/s	09/1800UTC	Limited shock

Figure 2: ENLIL representation of CME arrivals.

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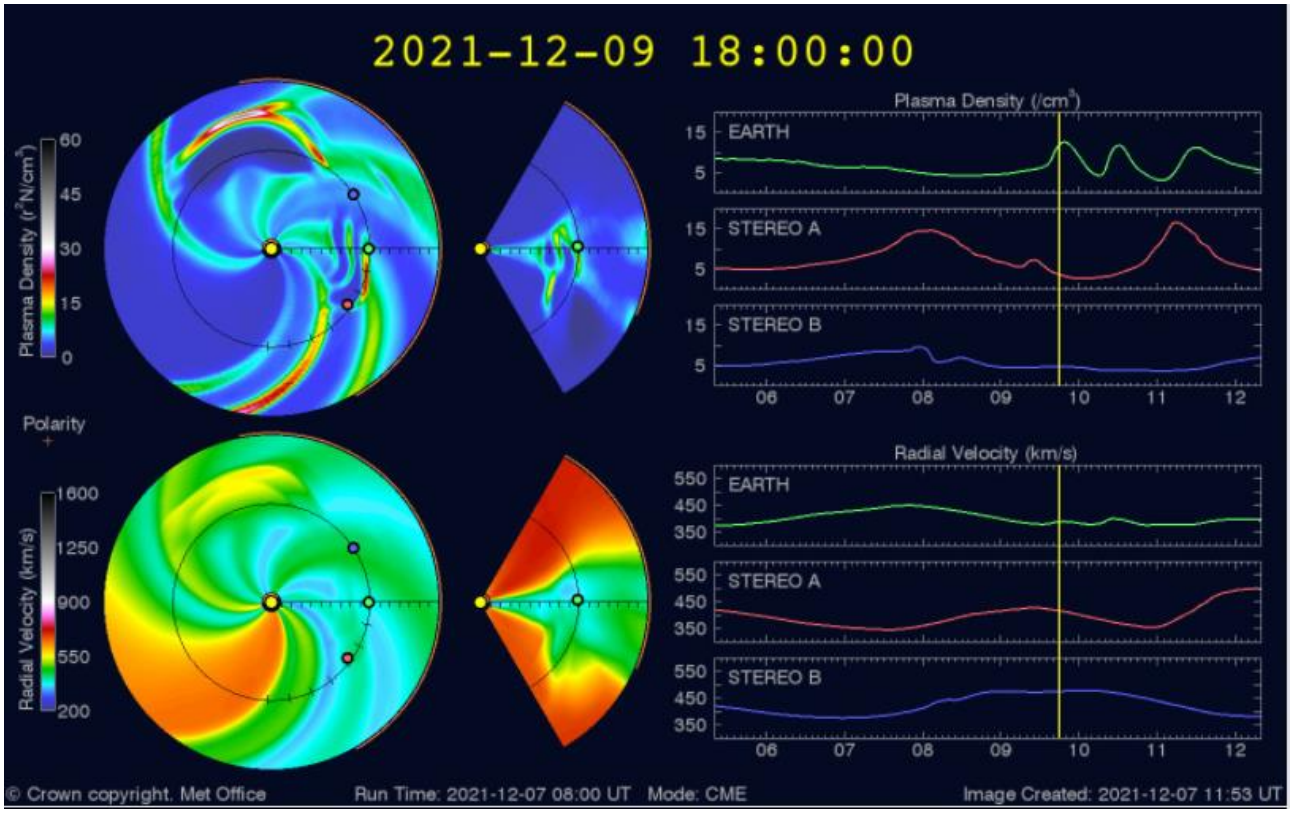

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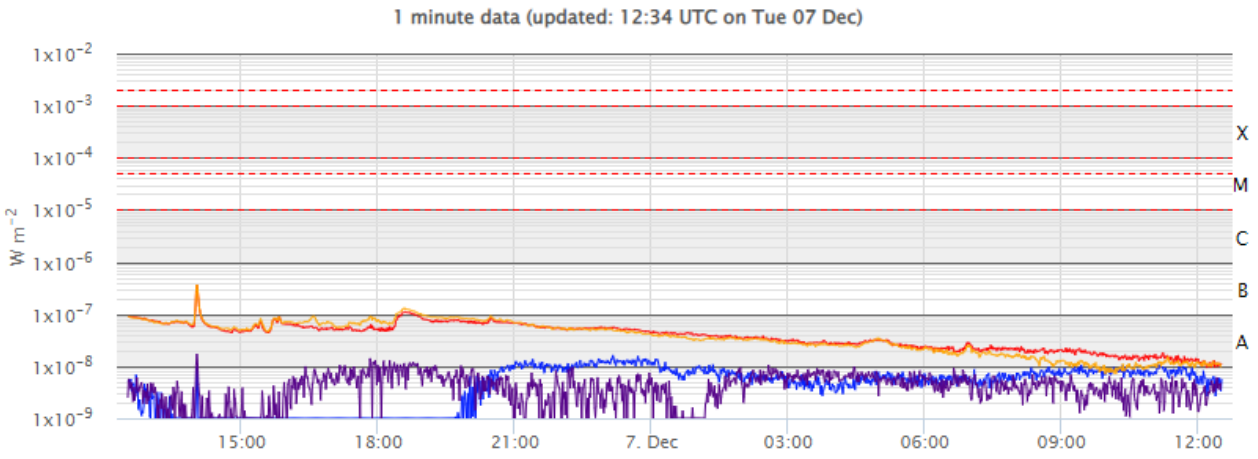
Radio Blackouts - X-Ray Flares:
Solar Activity became Very Low in the past 24 hours, with the chance of further observable flares from a narrowly far-sided active region quickly diminishing. X-ray flare activity therefore returns to the Earth-side and the sole remaining sunspot region; AR2904, which is currently small, simple and stable. No returning regions are due to rotate around the eastern limb in the period. Solar activity is forecast to be Low or Very Low, with only a daily Slight Chance (10%) of C-class flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: X-ray observations for the past 24 hours.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels, with no solar radiation storms anticipated.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 has been varying between Moderate and High levels during the last 24 hours, and is forecast to persist at this level, with a low chance of seeing peak values increase day-to-day. There is also the potential for a dropout in values from any geomagnetic activity due to a CME arrival on day 1 (Tuesday 07 December) or a CME/CH29 fast wind arrival on day 3 (Thursday 09 December).

The associated fluence is likely to rise a slightly on day 1, but is likely to stay below the Active with only a slight chance of rising above. There is some uncertainty with the potential for a day-to-day increase of peak flux levels leading to fluence potentially approaching the Active threshold, however REFM is currently suggesting levels remain below it, in-line with this forecast.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	30	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: REFM fluence observation and forecast.

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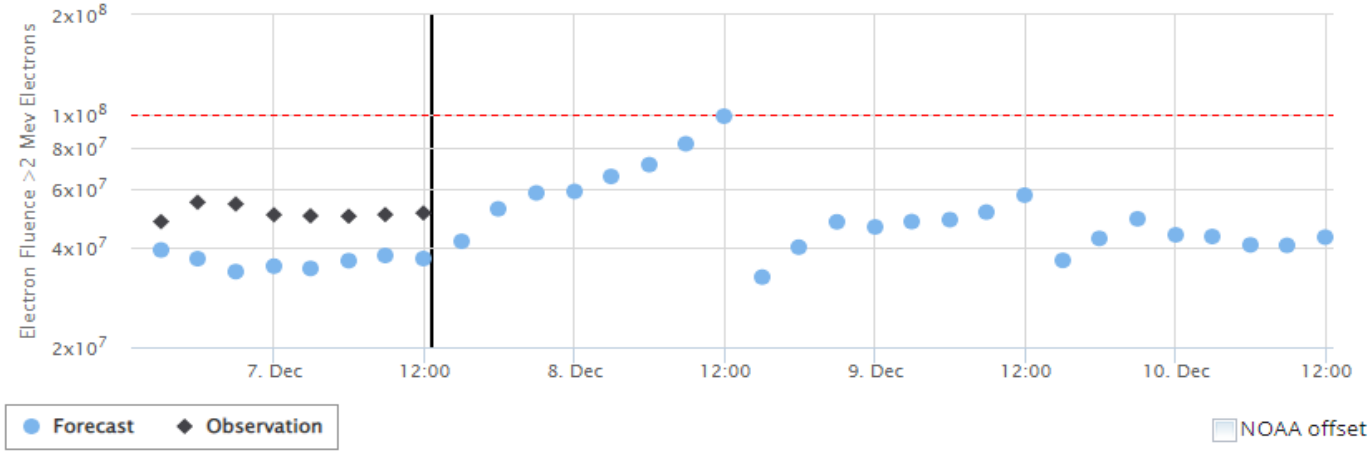

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